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ARTIFICIAL INTELLIGENCE IN ONCOLOGY: APPLICATIONS, CHALLENGES, AND FUTURE DIRECTIONS

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Annotation. Modern medicine — and oncology in particular — is on the verge of integrating artificial intelligence (AI) into routine clinical practice. This article highlights some of the most successful initiatives showcasing how AI is being applied in diagnosing and predicting the progression of cancer. Existing clinical decision support systems that incorporate neural network-based oncology diagnostic modules are examined. For the first time, the limitations of AI applications in oncology are discussed, along with strategies to address these challenges.

Keywords: artificial intelligence, early diagnosis, genetic markers, clinical decision support systems, bioinformatics, machine learning, personalized therapy.

ONKOLOGIYADA SUN'IY INTELLEKT: QO'LLANILISHI, MUAMMOLARI VA KELAJAK YO'NALISHLARI

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Annotatsiya. Zamonaviy tibbiyot, xususan onkologiya, klinik amaliyotga sun'iy intellekt (SI) texnologiyalarini joriy etish arafasida turibdi. Ushbu maqolada SI orqali saratoni aniqlash va uning rivojlanishini bashorat qilishda qo'llanilayotgan muvaffaqiyatli tashabbuslar haqida so'z yuritiladi. Onkologiyada neyron tarmoqlar asosida ishlovchi diagnostika modullarini o'z ichiga olgan mavjud klinik qaror qabul qilish tizimlari tahlil etiladi. Ilk bor SIning onkologiyadagi qo'llanilishidagi cheklovlar va ushbu muammolarni bartaraf etish strategiyalari muhokama qilinadi.

Kalit so'zlar: sun'iy intellekt, erta diagnostika, genetik markerlar, klinik qaror qabul qilish tizimlari, bioinformatika, mashinali o'qitish, personallashtirilgan terapiya.

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Introduction

Recent advances in diagnostic and therapeutic approaches have transformed the perception of cancer from an incurable disease to a condition that can be managed and, in many cases, successfully treated. Early detection of cancer is crucial for initiating effective therapy and improving patient survival. Ongoing research continues to focus on identifying optimal strategies for treatment and long-term monitoring of cancer patients.

Modern clinical oncology emphasizes personalized treatment strategies, taking into account a variety of factors related both to the tumor itself and to the patient's overall condition. Treatment plans are typically based on thorough analysis of clinical data, supported by global experience and evidence accumulated in the field of oncology. Traditionally, oncologists rely on their clinical expertise and judgment to recognize various manifestations of the disease and make diagnostic decisions. However, the accuracy of such decision-making may be limited by the physician's individual knowledge and cognitive capacity, which can sometimes result in diagnostic errors.

The human brain is not well-suited for processing and integrating vast volumes of data in real-time clinical settings. In contrast, artificial intelligence (AI) systems excel at analyzing large datasets efficiently. Machine learning methods, in particular, offer improved diagnostic accuracy for various types of cancer by training on extensive datasets and identifying complex patterns. As a result, the application of neural network technologies is becoming increasingly relevant for enhancing both diagnostic and therapeutic processes in oncology [1; p.-219].

This review explores the use of AI techniques in the diagnosis and treatment of cancer, as well as the challenges that currently limit the integration of neural network algorithms into routine oncological practice.

1. Applications of Artificial Intelligence in Oncology

As part of the national cancer control program, 2022 marked continued efforts to implement a new healthcare delivery model in oncology. This model emphasizes lean technologies to enhance internal workflows, optimize resource usage, and improve patient satisfaction by increasing access to high-quality care. Achieving better cancer treatment outcomes — including rehabilitation and potential cure — would be significantly more difficult without incorporating artificial intelligence (AI) systems into clinical oncology practice.

AI represents a modern technological approach that relies on advanced algorithms to process large volumes of medical data, enabling predictive insights even when certain inputs are missing. A key feature of AI is its ability to make rational decisions that emulate human cognitive functions.

Currently, the use of AI in oncology focuses on several major areas:

1. **Early detection of tumors** using histological images, CT scans, and MRI data by identifying tumor-specific features;
2. **Personalized treatment planning**, based on the molecular and biological characteristics of the tumor;
3. **Clinical decision support** for oncologists in managing patient care.

1.1 AI-Based Early Diagnosis of Tumors

Deep learning algorithms have demonstrated diagnostic accuracy that rivals — and sometimes surpasses — the performance of radiologists and pathologists in analyzing digital X-ray and histological images. AI tools are already widely used in radiology. In 2018, a team from Seoul National University College of Medicine developed an AI algorithm to detect precancerous and malignant lesions in chest X-rays. The algorithm outperformed 17 out of 18 radiologists when evaluated on the same set of images [1; p.-220-222].

Machine learning has also enabled precise differentiation between tumors and post-treatment inflammatory or necrotic tissue on CT and MRI scans — distinctions that are often misinterpreted as tumor progression, leading to unnecessary changes in treatment [2; p.-

731]. AI can also predict radiation-induced damage to the lungs, bladder, and intestines based on radiological findings.

In July 2020, SberHealth and the SberCloud platform launched an AI-powered CT scan interpretation service for lung imaging. Users can upload their scans and receive results in 10 minutes. The system identifies inflamed areas, assesses lung tissue changes (e.g., ground-glass opacities), and estimates the percentage of affected tissue.

The **Botkin.AI** platform offers diagnostic tools for pneumonia (including COVID-19), lung tumors, and mammographic screening. It incorporates:

Botkin Learning: an automated ML pipeline that trains and deploys updated models as new data is collected;

Botkin HAI (Hybrid AI): which combines AI-generated image analysis with physician validation and cross-checking;

Botkin Edge: a hardware-software solution that can be installed in clinics and integrated with PACS or other data sources for flexible, local image processing [1; p.- 226].

AI is also being used to **predict cancer progression** based on radiological characteristics. For instance, researchers have developed models to forecast distant metastasis in lung cancer patients [1; p.-221-223].

In countries with extensive histological image databases, deep learning has been successfully applied in **tumor morphology diagnostics**. One example includes using AI to assess the depth of prostate cancer invasion, achieving a 70% accuracy rate — outperforming general pathologists.

Neural networks have also been applied to **identify tumor-infiltrating lymphocytes** in histological samples, a factor of prognostic importance in cancers such as breast, lung, and colorectal cancer.

Google AI Healthcare developed the **Lymph Node Assistant**, an algorithm that analyzes lymph node tissue for breast cancer metastases. It achieved 91% sensitivity, even detecting subtle abnormalities invisible to the human eye [2; p.-733-734].

These methods allow AI to perform accurate tumor diagnostics **without a pathologist**, delivering fast and reliable results, often with expert-level precision. In the near future, deep learning will become an essential tool for radiologists and pathologists to improve diagnostic accuracy and efficiency in oncology.

AI has also proven effective in **dermatoscopic analysis**, identifying skin cancers, including melanoma, with expert-level accuracy of up to 96%. These systems can be implemented on smartphones, facilitating early cancer detection at scale.

Another innovative use of AI involves **non-invasive cancer detection** via exhaled breath analysis. A multisensor diagnostic system is trained to identify volatile compounds characteristic of cancer patients and distinguish them from healthy individuals. This method enables screening and referral for confirmatory tests (like biopsy). For cancers of the lung, larynx, and oropharynx, the technique achieved 80.16% accuracy (76.92% sensitivity and 82.61% specificity), comparable to CT and MRI diagnostics.

These diverse applications of AI in cancer diagnosis highlight its transformative potential in optimizing clinical workflows and improving patient outcomes.

1.2 The Role of AI in Cancer Genomics

A central challenge in oncology is the precise classification of tumors and the development of optimal treatment strategies. Histological analysis and the evaluation of molecular marker expression remain essential tools in tumor classification. However, significant heterogeneity can exist within tumors of the same histological type. Identifying molecular subtypes holds great promise for predicting disease progression and treatment response.

With the advent of genomic sequencing technologies and increased computational power, it is now possible to identify between 1,000 and 100,000 genetic mutations for a single cancer type. Establishing associations between these mutations and clinical characteristics, treatment outcomes, and prognoses is a key objective of modern genomic medicine. For example, the COSMIC (Catalogue of Somatic Mutations in Cancer) database, compiled by the Sanger Institute, provides a comprehensive link between genetic variations and disease. As of its September 2019 update, the database includes 9,733,455 gene mutations collected from 26,829 publications.

A meta-analysis involving 6,000 breast cancer patients identified 184 genes associated with prognosis, offering the foundation for training neural networks to enable personalized treatment strategies and risk stratification.

One example of AI application in cancer genomics is the **ExPecto** algorithm, which links genetic mutations with disease prognosis based on publicly available genome-wide association data. Similarly, deep learning models analyzing gene expression levels across various mutations can help uncover the complex etiology of malignancies and identify novel molecular markers. For instance, AI has been used to reveal the role of **Fbxw7**, a frequently mutated E3 ubiquitin ligase in cancer, in regulating oxidative metabolism and maintaining quiescence in cancer stem cells — insights that may inform future therapies.

In a single-center study in the Netherlands, an AI-driven decision support system outperformed experienced oncologists and the EORTC guidelines in predicting two-year survival among lung cancer patients. The model utilized input features such as gender, physical status, forced expiratory volume, total tumor volume, and lymph node involvement. These results underscore the ability of neural networks to identify alternative, highly accurate predictors of treatment outcomes and survival.

In summary, the application of AI in cancer genomics allows for improved classification of patients based on tumor aggressiveness, treatment response, and expected outcomes. Such systems rely on deep learning, incorporating molecular and biological tumor characteristics and extensive clinical experience. This facilitates the selection of optimal chemotherapy regimens and the identification of high-risk patients who may require more aggressive treatment. The continued development of AI in genomics is expected to yield deeper insights into cancer biology and support more personalized treatment approaches.

1.3 AI-Based Clinical Decision Support Systems (CDSS)

Artificial intelligence has become a key driver in the advancement of precision medicine. In 2018, the **Arterys** cloud platform received regulatory approval in the U.S. as a decision-support tool for analyzing MRI scans to detect lung and liver tumors. Since 2019, several AI-focused startups, including **PAIGE.AI**, **Proscia**, and **PathAI**, have been developing deep learning–based tools to classify and predict various types of cancer.

These AI-driven decision support systems are especially valuable in cases involving diagnostic uncertainty or multiple valid clinical interpretations. One example is **Care Mentor AI**, which offers radiology services and decision support based on AI analysis. The platform can detect, classify, and describe pathological findings from chest X-rays, CT scans for lung cancer, and mammography. Future developments include MRI brain analysis and PET-CT image interpretation.

Another notable initiative is **Third Opinion**, a non-profit organization developing predictive analytics and risk management tools for healthcare. Its projects include AI-based recognition of pathologies in radiographs and histological images, such as bone marrow smear analysis and lung imaging.

In Moscow, the **Unified Radiological Information Service (URIS)** was created by the Center for Diagnostics and Telemedicine, processing over 1.5 million studies by June 2022, with more than 1,000 radiologists evaluating AI-generated results.

WEBIOMED, the first officially registered AI medical system in Russia, integrates with electronic health records to provide real-time risk assessments and personalized preventive recommendations based on depersonalized data.

Overall, AI-based CDSS in oncology can enhance treatment monitoring, facilitate access to global clinical guidelines, reduce adverse events, and lower healthcare costs. While AI offers multiple recommendations, the physician remains the final decision-maker, responsible for interpreting the information critically and selecting the best course of action.

2. Limitations and Solutions for AI Integration in Oncology

In 2014, IBM launched the Watson Group to commercialize cognitive computing technologies, with healthcare as a primary target. Solutions like **Watson for Oncology** and **Watson for Clinical Trial Matching** aimed to synthesize patient histories, clinical notes, and relevant literature to generate treatment recommendations.

However, in 2018, reports emerged that IBM Watson often failed to meet expectations. Internal evaluations showed that the system sometimes proposed inappropriate or even unsafe treatments. As a result, several clients withdrew from partnerships with IBM Watson Health, and further reviews revealed that Watson's recommendations aligned with clinical decisions only in selected cancer types.

One major challenge in implementing AI in clinical oncology is the **"black box"** nature of deep learning models — their internal logic is not always transparent. This has prompted a shift toward **"white box"** models, or interpretable AI, as a key research priority in biomedical science.

Additionally, the effectiveness of AI in radiology depends heavily on the availability of large, diverse datasets. Most image datasets contain fewer than one million samples — insufficient for robust machine learning. Solutions include image augmentation (rotations, flips, cropping) to increase dataset size without altering diagnostic features. Transfer learning, using large datasets like **ImageNet**, is another viable strategy [1; p.-224-225].

In histopathology, standardization remains a challenge. Variability in staining procedures between institutions complicates automated analysis. Tools like **HistoQC** and **DeepFocus** have been developed to normalize image quality using grayscale inputs derived from H&E-stained images [1; p.-224-225].

In summary, the main limitations to AI adoption in oncology include data scarcity, lack of algorithm transparency, and protocol variability. Nonetheless, the demonstrated diagnostic accuracy of AI justifies further development, with machine learning expected to play an increasingly supportive role in oncology decision-making.

Conclusion

1. AI technologies demonstrate high accuracy in the diagnosis of cancerous diseases.

2. Using AI to select treatment plans and predict disease progression — based on tumor molecular characteristics and clinical data — shows great promise.

3. Integrating AI's diagnostic and prognostic capabilities into clinical decision support systems will reduce physician workload and improve care quality.

Researchers are actively working to overcome current AI limitations, enhancing its future impact on cancer diagnosis and treatment.

Adabiyotlar/Литература/References:

1. Nam JG, Park S, Hwang EJ et al. Development and validation of deep learning–based automatic detection algorithm for malignant pulmonary nodules on chest radiographs. doi:10.1148/radiol.2018180237 // Radiology. 2019;290(1):218–228. URL:https://pubs.rsna.org/ doi/10.1148/radiol.2018180237 (access date: 29 April 2022). ISSN (Online) 1527-1315.
2. Du D, Feng H, Lv W et al. Machine Learning Methods for Optimal Radiomics-Based Differentiation Between Recurrence and Inflammation: Application to Nasopharyngeal Carcinoma Post-therapy PET/CT Images. doi:10.1007/s11307-019-01411-9 // Mol Imaging Biol. 2020;2(3):730–738.

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